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MATERIALS

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION REPORT-ABANDONED DUMP SITE

PROJECT
CONRAD I-15 NORTH INTERCHANGE MODIFICATIONS
Conrad, Montana
MT 15-7(32)449 Control 5944

PROJECT NUMBER 06-340

CLIENT
MORRISON-MAIERLE, INC.
Helena, Montana

PREPARED BY
NTL ENGINEERING & GEOSCIENCE, INC.
Great Falls, Montana

January 14, 2008

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Appendix

Introduction

The following Geotechnical Investigation Supplement presents additional subsurface data for the existing fill/dump site beneath the planned alignment for the modified Northbound I-15 On-Ramp and discussions on the results of the field investigation for the Conrad Interchange Modification Project in Conrad, Montana. General project information, field and laboratory investigation methods, discussions of subsurface information, and engineering analysis/recommendations is provided in our Geotechnical Investigation Report dated October 24, 2006.

The supplemental drilling program consisted of five borings bordering the area found to have weak conductivity anomaly along the proposed alignment as mapped by UMS (Utility Mapping Services, Inc.) plus one additional boring through the existing Northbound On-Ramp to I-15. All borings were advanced to 21.5 feet below ground surface. The field investigation was conducted using NTL's CME 75 truck-mounted drill rig under the direction of our engineer. Continuous logs of the subsurface conditions were recorded, Standard Penetration Testing (SPT) conducted, and undisturbed samples obtained. Groundwater and seepage zone observations were made during the drilling. A generalized description of field investigation methods is further provided in the **Appendix**.

Subsurface Conditions

Subsurface materials generally included fill overburden materials overlying glacial till (lean clay with sand and gravel). The prominent strata are described more thoroughly in the following paragraphs:

- **Fill, Clay with Gravel and Debris**

  The majority of fill encountered during the supplemental drilling program was generally considered uncontrolled fine-grained material with a small percentage of gravel and sand-sized particles. The standard spoon samples and auger cuttings indicated that the fill also included glass, cinders, wood, ceramics, metals and other debris. Also included in the fill classification is the embankment material for the existing Northbound On-Ramp to I-15 which presumably was placed as a controlled fill. The upper portion of embankment fill consisted of poorly-graded gravel with sand to a depth of 2.5 feet below top of embankment, most likely an imported gravel material. The embankment transitions to a lean clay with sand and gravel material consistent with mechanically reworked glacial till.

  Moisture contents in the range of 7 to 26 percent were measured with the average moisture content near 15 percent, typically near the Plastic Limit. The moisture near the interface with the underlying glacial till appeared to be higher, with noted seepage zones prevalent in numerous borings. Liquid Limit and Plasticity Index values for the clay with gravel fill material were found to be 43 and 28 percent respectively (Plate No. 1). Standard Penetration Testing found blow counts in the range of 4 to 38 blows, with typical values in the mid-teens indicating a stiff to very stiff consistency material. Gradation testing on the fill material from the upper portion of the Northbound On-Ramp embankment at 2.5 feet below ground surface determined that approximately 76 percent of the soil mass was comprised of fine-grained particles (Plate No. 2).

- **Glacial Till, Lean Clay with Sand & Gravel (A-7-6 & A-6)**
  A zone of glacial deposited clay materials was encountered in all borings beneath the fill material. SPT recorded N-values ranging from 10 to 39 blows per foot indicating stiff to very stiff material; typical values were on the order of 15 blows per foot. Moisture contents ranged between 16 and 24 percent; typical values were near 18 percent. The material can be expected to exhibit plasticity and strength parameters as determined by previous testing for the original geotechnical investigation.

Groundwater Conditions

Observations for groundwater or seepage were made during drilling. The majority of our borings encountered seepage zones at the interface of fill and glacial till material, generally between 9.0 and 10.0 feet below ground surface. Groundwater levels are shown on the attached Logs of Boring. Numerous factors contribute to groundwater fluctuations and occurrence of seepage; evaluation of these factors requires special study that is beyond the scope of this report.

Engineering Discussion

Additional Site Investigation

During our original Geotechnical Investigation for the Conrad Interchange Modifications project, boring data indicated, in conjunction with comments from local community members, that an abandoned landfill area had at one time occupied the area near the existing northbound interchange off-ramp. The partial cloverleaf construction of the northbound interstate off-ramp encompassed the zone thought to be the abandoned landfill. Initially it was proposed that a boring be located in the zone of the claimed abandoned landfill to eliminate the use of that zone for the new on-ramp alignment. However, the new/proposed alignment of the northbound interstate on-ramp placed new embankment and pavement directly over the abandoned landfill area, and concerns were raised about the effects of the poor subgrade/uncontrolled fill on the new roadway construction. After discussions on the concerns, the new/proposed alignment was determined to be necessary for traffic flow issues and a subexcavation and removal method for reducing potential settlement and differential performance over the landfill zone was noted in our original Geotechnical Report dated October 24, 2006. It was decided that further field investigation, both geophysical and geotechnical, should be conducted to provide as accurate a representation of the abandoned landfill limits as possible for the purpose of defining the subexcavation and removal zone more clearly to move forward with design of the new/proposed alignment.

A geophysical electro-magnetic survey was first conducted by Utility Mapping Services, Inc. (UMS, Inc.) to provide approximate boundaries of the abandoned landfill site based on weak conductivity anomalies along the survey lines believed to signify the presence of uncontrolled fill (see appended **Conrad Geophysical Survey** by UMS, Inc.). The geophysical survey data and approximate landfill boundary anomalies were then used to position geotechnical boreholes to create a 3D representation of the landfill zone subsurface conditions. NTL was able to lay out the borings for the field investigation to allow for two distinct cross sections, in the general north-south (**Plate**

A-A) and east-west (**Plate B-B**) directions. During the field investigation GPS coordinates were recorded for the boring locations and placed on the attached **Supplemental Site Plan-Abandoned Dump Site**.

Interpretation of Investigation Results

The use of the geophysical survey and the geotechnical boring data allowed estimation of the approximate boundaries of subexcavation required to limit potential differential performance and settlement concerns for the Northbound I-15 On-Ramp. The results are a quasi 3D representation of the abandoned landfill area.

The focus of the supplementary geotechnical investigation was on the area of the geophysical survey in which anomalies appeared to indicate the main landfill area in the center of the partial cloverleaf Northbound I-15 Off-Ramp. Five supplementary borings were located near the apparent boundary of the main landfill area in an attempt to put limits on the uncontrolled fill to establish boundaries for subexcavation and replacement. During the supplementary investigation, the greatest depth of fill was found in Boring LF-4, in which fill was encountered to a depth of approximately 10.6 feet below ground surface. Boring LF-4 was located on the eastern edge of the possible main landfill area boundary. The borings located on the western and northern edge of the possible main landfill area, LF-2 and LF-5 respectively, encountered the native glacial till at shallower depths, approximately ±5.0 feet below the ground surface. This indicated a depression that sags toward the center of the partial cloverleaf where the anticipated extent of the fill reaches approximately 11 feet below ground surface. The generalized subsurface profile is given in two plates attached (see **Plate A-A** and **Plate B-B**), that used the boring data along with the estimated projected to the anomaly borders to generate the most likely cross-section of the abandoned landfill area. The general subsurface profile information gathered indicates that the majority of the abandoned landfill area has uncontrolled fill to a depth less than 11 feet below ground surface.

The survey and subsurface results indicate that the primary abandoned landfill is located within enclosure created by the existing partial cloverleaf for the Northbound I-15 Off-Ramp. The geophysical survey indicates that the abandoned landfill potentially could have limits that extended beyond the enclosure to the north. The lines of weak conductivity extend to the north beyond the off-ramp into the triangular shaped area between the Northbound lanes of traffic on I-15 and the existing Northbound I-15 On-Ramp. In our previous geotechnical investigation Boring B-9 was located in that triangular area and no fill was encountered at that location. The geophysical data indicates that the anomaly trend line continues to the west of that B-9 location and is more likely a shallower extension of the abandoned landfill deposit. With a combination of the geophysical data and the geotechnical boring results, it can be assumed that the landfill trend as indicated on the UMSI Geophysical Survey does indeed extend north along the proposed alignment. Subexcavation and replacement along the proposed alignment of the Northbound On-Ramp to the intersection of the interstate should be anticipated. For reference we have attached in the **Appendix** the Geophysical Survey Services Report prepared by UMSI dated December 15, 2007.

Northbound I-15 Off Ramp Recommendations

The most positive solution for subgrade improvement for the new/proposed alignment would be the removal and replacement of the uncontrolled fill profile in the abandoned landfill area. This would require a nominal subexcavation and replacement beneath the embankment footprint to a depth of approximately 11 feet below existing grade. The subexcavation limits would be such that all subgrade bearing material potentially impacted by the placement of the new embankment would be native or controlled replacement fill. The depth limits necessary to satisfy this criterion should be developed consistent to the attached **Detail 1**. The replacement material should meet the recommended requirements for Structural Fill noted in the **Recommendations** section, should be placed in controlled lifts, and compacted to recommended minimum density requirements. To bolster reliability and long-term performance of the replacement material, a layer of separation geotextile (such as Mirafi 160N) should be placed throughout the base of the subexcavation to limit potential for native fine-grained particles intruding into the Structural Fill. The construction subexcavation should be monitored and approved by a geotechnical engineer to ensure complete removal of uncontrolled fill material and proper preparation of the base of excavation.

Current Embankment Material Analysis

While on site to perform supplementary drilling for the abandoned landfill area, we conducted one boring through the existing Northbound On-Ramp embankment. The boring was conducted to classify the materials currently comprising the embankment, which were consistent with mechanically re-worked glacial till materials. The existing embankments to the east of the interstate appear to be performing well under current loading conditions with no significant rutting observed and little distress to the pavement section noticed. With the materials identified in Boring Emb-1 and the visual reconnaissance of the current conditions of the embankments to the east of the interstate, it appears the embankment fill material would be a suitable source of material to be used in the new embankment construction. The current plan for construction has the embankments being demolished. If the material can be stockpiled close to the site or kept on-site, it could be an acceptable source for embankment fill. A shrinkage factor in the range of 20 to 30 percent can be assumed for the clayey embankment fill materials during initial planning. This value should be reviewed once borrow sources are selected, or the decision to use current embankment materials is made.

Embankment Settlement and Pavement Analysis

The supplementary drilling program has been designed and conducted to provide limits on the subexcavation and replacement zone of the uncontrolled, abandoned landfill area. In our Geotechnical Investigation Report dated October 24, 2006, a settlement analysis was conducted based on interpretation of the consolidation test data, noting that the added stresses of the proposed embankments are less than the pre-consolidation pressures already exerted on the native clays (2,000 psi ±), and settlement magnitude is expected to be relatively small. Settlement analysis was conducted based on laboratory consolidation testing and the soil profile for fill sections near Station 216+00 (Ramp C-4) and 218+00 (Ramp C-4) where approximately 11.5 feet and 16 feet of fill are anticipated. Analysis found centerline settlement magnitudes on the order of 1.50 inches to 2.00 inches for these sections. These settlement magnitudes were calculated based on a granular embankment fill material being placed directly on native clay materials. In the subexcavation and replacement of the abandoned landfill area the new embankment material will be placed directly on approximately 11 feet of controlled granular fill material. The settlement within the 11-foot granular replacement fill zone is estimated at less than 0.25 inch and is expected to occur rapidly with construction. Centerline settlement magnitudes on the order of 1.50 inches for the anticipated section over the abandoned landfill area can be conservatively estimated assuming minimal settlement in the granular fill zone. New embankment construction height in the subexcavation and replacement zone is likely to be less than the analyzed 16 feet.

Pavement sections submitted in our Geotechnical Investigation 4.0 Supplement for Ramps C-3 and C-4 are considered valid for the subexcavation and replacement conditions at the abandoned landfill site. The subexcavation and replacement has no significant impact on the pavement subgrade soil strength parameters.

Assuming the use of granular fill material, the maximum slope ratio should not exceed 2H:1V for fill slopes. Slope flattening based on geometric design criteria should be conducted in accordance with current MDT design standards to facilitate topsoiling and the establishment of vegetative growth.

Foundation Stability

In our original Geotechnical Investigation Report, dated October 24, 2006, stability analysis was conducted to access foundation bearing capacity within the underlying lean clay material with the additional loading case of embankment construction. The stability analysis was conducted for $\phi = 0°$ conditions and a soil profile consisting of a nominal 10 foot layer of lean clay material at ground surface overlying a stiff glacial till material. In that analysis, it was assumed that embankment construction proceeds so rapidly that pore pressures in the clays will not dissipate. In the subexcavation and replacement zone of the abandoned landfill, the underlying material will be an imported granular fill with better strength parameters than the embankment material overlying a stiff glacial till material.

The analysis was conducted using the computer program STABL6H to provide limiting equilibrium solutions for two-dimensional, circular failure surfaces generated both in the lean clay and glacial till materials. In this analysis method, a factor of safety is computed by comparing available shear strength along a prospective failure surface to the shear strength required to barely maintain stability. When these two strengths are equal, failure impends, and the factor of safety (FS) approaches a value of 1.0. Typically, factors of safety on the order of FS = 1.5 are considered acceptable.

In the original Geotechnical Investigation Report, the controlling analysis was conducted on a steepened slope section of 2H:1V to demonstrate slope steepening as a possibility for construction, and resulted in a Factor of Safety (FS) against slope failure of 4.27. The use of steepened slope has been analyzed again with the parameters for the foundation soil conditions changed from a lean clay to a granular fill material. The result indicate a FS of 4.40 for embankment sections of subexcavation and replacement zone of the landfill. The analysis was conducted on an embankment section 16 feet high, which will be approximately 5 feet higher than the typical section over the abandoned landfill subexcavation and replacement zone. The 16 foot high section was used for consistency with the original Geotechnical Investigation Report for the controlling section.

Based on these results, we conclude that safety with regard to sliding in the embankment material near surface is within normally accepted limits

Recommendations

The following recommendations have been developed assuming that construction will be conducted in accordance with the MDT Standard Specifications for Road and Bridge Construction.

1.0 General Site Preparation

1.1 The removal of uncontrolled fill, topsoil and other organic material, including the clearing and grubbing of surficial vegetation and roots, should be accomplished within the construction zone prior to any earthwork or foundation construction; this includes removals from existing embankment and embankment slope faces to which fill is to be added. All existing structures, pavements, culverts, sidewalks, and other obstructions to planned work should be removed prior to construction. Cavities left by obstruction removal should be backfilled in accordance with compaction criteria outlined in Item 2.1.

1.2 Surface drainage should be established to direct runoff away from the construction area.

2.0 Subgrade Subexcavation Replacement Materials

2.1 Bedding Material consistent with MDT Standard Specifications 701.04.1-Table 701-17 is acceptable for subgrade subexcavation replacement. The replacement material should be developed from reliable source(s) approved by our geotechnical engineer and meet the following gradation and composition requirements:

Screen or Sieve Size	Percent Passing by Weight
4-inch	100
1 1/2-inch	50-100
No. 4	25-60
No. 200	12 maximum

- The sand, gravel, and cobble-size particles comprising the fill must be hard, durable rock materials that will not degrade by moistening or under mechanical action of the compacting equipment; i.e. not shale or other clayey rock types.

- The binder/fines fraction should have maximum Liquid Limit and Plasticity Index values of 25 and 10 percent respectively.

- No frozen, organic, or other deleterious materials should be present in the fill aggregate.

2.2 Structural Fill should be placed in uniform lifts not exceeding a 12-inch loose thickness and be compacted to at least 98 percent of the maximum dry density per AASHTO T99. Structural Fill should not be placed on frozen subgrade material.

2.3 The use of on-site clay soils is not recommended for replacement material used in the subexcavation of the abandoned landfill zone. The on-site clay soils can only be compacted to satisfy this criteria within a relatively narrow band of moisture; some, and possibly considerable, adjustment of natural moisture contents would be expected by the contractor.

2.4 Geotextile for use beneath the Structural Fill as part of the replacement zone for the subexcavation shall be a High Survivability, woven material as defined in Item 716.01 of the MDT Standard Specifications, 2006 Edition. The geotextile should be place in accordance with Item 622.03.2 of those specifications and include a minimum overlap of 3.0 feet for adjacent sheets.

3.0 Subgrade Subexcavation Preparation

3.1 In preparation for new/proposed Northbound I-15 On-Ramp construction, the replacement zone should be subexcavated to the minimum limits (lateral and vertical) as shown on **Detail No. 1.** Subexcavation depth is to be not less than 11 feet below existing ground surface. The final 1-foot of the subexcavation should be conducted using a smooth bucket excavator from above the final elevation of the subexcavation to limit construction disturbance to the base of the excavation. If disturbance to the bearing surface is caused by construction equipment, the native glacial till subgrade should be re-compacted to a minimum 95 percent of AASHTO T99 maximum dry density for the material. Any areas where rutting, yielding, or other non-uniform subgrade performance is observed, should be repaired and improved as recommended by a geotechnical engineer.

3.2 Following the subexcavation, the base is to be approved by our Geotechnical Engineer before application of the High Survivability Geotextile (Item 2.4) and subsequent construction of the Structural Fill layer.

4.0 Embankment Borrow Material

4.1 Current information regarding the existing embankment construction indicates that borrow materials from this "on-site" source would be of clayey texture. Such materials are acceptable for reuse in new embankment construction provided that compaction is conducted in accordance with specified MDT procedures. Geotechnical observation of fil excavation should be conducted to assure that materials are within acceptable limits for use as new embankment material.

4.2 Shrinkage factor for "on-site" borrow source can be conservatively assumed for preliminary planning to be within the range of 20 to 30 percent

5.0 Construction Services/Quality Control

5.1 Geotechnical Observation should be provided to monitor the subexcavation and replacement for the abandoned landfill zone. These geotechnical services should ascertain that subsurface conditions are reasonably consistent with those determined by our investigation, and should ascertain that subexcavation limits and subgrade preparation are consistent with our recommendations. It is particularly important that geotechnical observation of subgrade preparation be thoroughly conducted to document conditions and contractor approach as well as provide appropriate recommendations for any necessary adjustments to subexcavation limits.

Conclusion

The foregoing recommendations present our supplemental geotechnical input for design and construction of the new/proposed Northbound I-15 On-Ramp at the site of the Conrad Interchange Modifications. In order for these recommendations to be properly incorporated in the subsequent design and construction stages, we recommend that our geotechnical and construction materials engineering staff remain involved with the project to ascertain that our recommendations have been properly interpreted both during design and construction. These services will reduce the potential for misinterpretation of subsurface conditions and geotechnical design recommendations that are important in the preparation of project plans, specifications, and bid documents.

NTL is a member of the Association of Engineering Firms Practicing in the Geosciences (ASFE), which is a professional organization whose purposes include the reduction of potential liabilities to member firms and project owners by quality-based engineering selection and positive owner-engineer interaction during the design and construction processes. Attached in the **Appendix** is an information sheet regarding geotechnical engineering reports and their limitations prepared by ASFE.

Limitations

NTL Engineering & Geoscience has strived to prepare this report in accordance with generally accepted geotechnical engineering practices in this area solely for use by the client for design purposes and is not intended as a construction or bid document representing subsurface conditions in their entirety. The conclusions and recommendations presented are based upon the data obtained during the supplementary investigation as applied to the proposed site grading and construction details discussed in this report. The nature and extent of variations between the borings may not become evident until construction. If variations are then exposed, it will be necessary to reevaluate the recommendations of this report.

If changes in the concept, design data, or location of the project are planned, the recommendations contained in this report shall not be considered valid unless the changes are reviewed by our geotechnical engineer, and the recommendations of this report modified or verified in writing.

Prepared By: ______________
Matthew D. Hoffmann, E.I.
Geotechnical Engineer

Reviewed By: ______________
Gary A. Quinn, P.E.
Sr. Geotechnical Engineer

Appendix

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

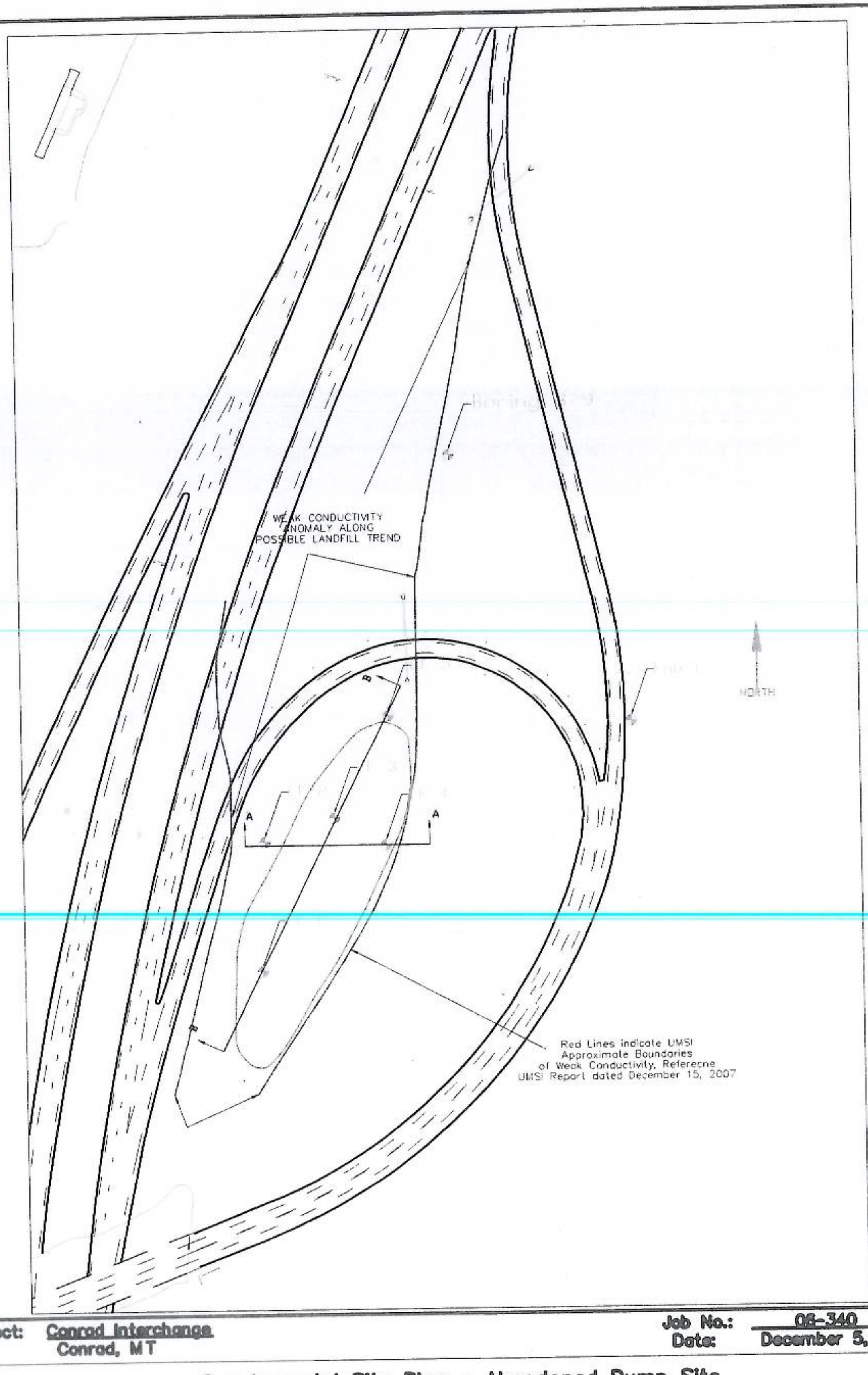
EXPLANATION OF FIELD INVESTIGATION METHODS

Prior to drilling and sampling of subsurface materials, a preliminary field reconnaissance was conducted to verify utility clearance, note surface drainage patterns, and identify pertinent geologic features that may have bearing on analysis. The preliminary reconnaissance includes literary review of geology and soils-related problems identified for other sites nearby or for similar expected soil conditions. Boring locations and planned depths are reviewed based on this reconnaissance.

The drilling program was conducted using a CME-75 truck mounted drill rig with 4 1/4-inch hollow-stem auger equipment and either smooth-blade or tri-cone rock bits. The hollow-stem augers serve as a casing for the boring and allow sample recovery by Standard Penetration Testing (SPT), ring sampling using a modified California Sampler, and by using thin-walled steel tube (Shelby Tube). The soils are continuously logged by an engineer or geologist and classified by visual examination in accordance with the Unified Soils Classification System; observation and grab sampling of auger cuttings is necessary to completely log the boring. Groundwater levels and seepage zones were noted as encountered and measured in the hollow-stem augers once stabilized. Slotted PVC observation wells may be installed to record long-term groundwater levels.

Samples of soils are taken at frequent intervals in the boring typically by SPT methods. The SPT testing was conducted in general accordance with ASTM D1586 using a split spoon sampler with a 2-inch outside diameter driven 18 inches into the soil by dropping a 140-pound hammer 30 inches. The total number of hammer blows required to advance the sampler the second and third 6-inch increments is the standard penetration resistance, or N-value. Split spoon samples were also recovered using a larger sampler having an outside diameter of 3-inches.

Undisturbed samples are obtained from layers of soil that are critical to the analysis. The Shelby Tube samples were obtained by pushing a 3-inch diameter, thin-walled steel tube into the soil to obtain a reasonably undisturbed sample. These samples are used to determine in-place density and can be trimmed to fit into laboratory consolidation and shear testing devices.



Project: Conrad Interchange
Conrad, MT

Job No.: 06-340
Date: December 5, 2007

Supplemental Site Plan - Abandoned Dump Site
NTL Engineering & Geoscience, Inc
Great Falls, MT

LOG OF BORING

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 227+20, 390' Rt of CL		Borehole Number: EMB-1	Sheet 1 of 1
Drilling Equipment: CME 75	Hammer: Type: Auto	Driller: NTL Engineering	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/3/2007	Date Finished: 8/3/2007
Elevation and Datum: Ground: 3497.00	Casing:	Notes:	

DEPTH (feet)	OPERATION	DRILL PRESSURE (psi)	DRILL RATE (fph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
0	Auger					Split Spoon		27		1				**FILL, Poorly-Graded Gravel with Sand**, medium dense, damp, subangular gravels, some silt, light brown		
2.5	Auger					Shelby		Grab			43	15		**FILL, CLAY with Gravel**, firm to very stiff, moist, subround gravels, trace organics, some sand, brown	2.5	A-7-6 (20)
5	Auger					Split Spoon		9		16				See Plate Nos. 1 & 2 for Test Data		
10	Auger					Split Spoon		19		19						
15	Auger					Split Spoon		6		18				trace gypsum @ 15.0'		
20	Auger					Split Spoon		15		17				**Glacial TILL, Lean Clay with Sand and Gravel**, stiff to very stiff, moist, trace carbons, trace oxidation, some salts, subround gravels, brown (CL)	19.5	A-7-6
															21.5	

End of Boring EMB-1 @ 21.5'

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Shelby; Bulk Sample; Grab Sample; Ring Sample; Large Split Spoon; Special Samplers; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ____ ft Upon Completion of Drilling ____ ft

Time After Drilling ____ ____ ____ ____

Depth To Water (feet) ____ ____ ____ ____

Remarks:

LOG OF BORING

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 223+00, 50' Lt of CL		Borehole Number: LF-1	Sheet 1 of 1
Drilling Equipment: CME 75	Hammer: Type: Auto	Driller: NTL Engineering	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/3/2007	Date Finished: 8/3/2007
Elevation and Datum: Ground: 3491.00 Casing:		Notes:	

DEPTH (feet)	DRILL OPERATION	DRILL PRESSURE (psi)	DRILL RATE (fph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
	Auger					Split Spoon		27						**TOPSOIL, Organic Matter**	0.2	
	Auger					Split Spoon		10		12				**FILL, CLAY with Gravel**, very stiff to firm, moist, subround gravels, trace organics, some sand, wood debris, glass, ceramics, brown less gravels @ 1.5'		
5	Auger					Split Spoon / Shelby		7 Grab		21				glass and cinders in cuttings and color change to black/dk brown @ 5.0'		
10	Auger					Split Spoon		12		17				seepage zone encountered @ 9.8'	10.5	
	Auger													**Glacial TILL, Lean Clay with Sand and Gravel**, stiff to very stiff, moist, trace carbons, trace oxidation, some salts, subround gravels, brown (CL)		
15	Auger					Split Spoon		23		17				increased drilling pressure noted @ 15.0'		A-7-6
20	Auger					Split Spoon		34		18					21.5	

End of Boring LF-1 @ 21.5'

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Ring Sample; Shelby; Large Split Spoon; Bulk Sample; Special Samplers; Grab Sample; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ____ ft Upon Completion of Drilling ____ ft

Time After Drilling ____ ____ ____ ____

Depth To Water (feet) ____ ____ ____ ____

Remarks:

LOG OF BORING

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 224+65, 70' Lt of CL	Borehole Number: LF-2	Sheet 1 of 1	
Drilling Equipment: CME 75	Hammer: Type: Auto	Driller: NTL Engineering	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/3/2007	Date Finished: 8/3/2007
Elevation and Datum: Ground: 3491.50	Casing:	Notes:	

DEPTH (feet)	DRILL: OPERATION	DRILL: PRESSURE (psi)	DRILL: RATE (fph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
	Auger					Split Spoon		38		8				**TOPSOIL, Organic Matter**	0.2	
														FILL, CLAY with Gravel, very stiff to stiff, moist, subround gravels, trace organics, some sand, some salts, glass, ceramics, brown		
						Split Spoon		10		13					4.2	
5						Split Spoon		15		20				**Glacial TILL, Lean Clay with Sand and Gravel**, stiff to very stiff, moist, trace carbons, trace oxidation, some salts, subround gravels, brown (CL)		A-7-6
10						Split Spoon		12		18						
														increased drilling pressure @ 13.5'		
15						Split Spoon		15		17						
20						Split Spoon		23		17					21.5	

End of Boring LF-2 @ 21.5'

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Shelby; Bulk Sample; Grab Sample; Ring Sample; Large Split Spoon; Special Samplers; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ____ ft Upon Completion of Drilling ____ ft

Time After Drilling ____ ____ ____ ____

Depth To Water (feet) ____ ____ ____ ____

Remarks:

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

LOG OF BORING

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 225+15, 18' Rt of CL	Borehole Number: LF-3	Sheet 1 of 1	
Drilling Equipment: CME 75	Hammer: Type: Auto	Driller: NTL Engineering	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/3/2007	Date Finished: 8/3/2007
Elevation and Datum: Ground: 3491.00	Casing:	Notes:	

DEPTH (feet)	DRILL OPERATION	DRILL PRESSURE (psi)	DRILL RATE (fph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
														TOPSOIL, Organic Matter	0.7	
								22						**FILL, CLAY with Gravel**, very stiff to stiff, moist, subround gravels, trace organics, some sand, wood debris, glass, ceramics, cinders, steel bolt in cuttings, brown/black		
5								8		26						
														seepage zone encountered @ 8.9'		
10								PUSH	114	16				**Glacial TILL, Lean Clay with Sand and Gravel**, very stiff to stiff, moist, trace carbons, trace oxidation, some salts, subround gravels, brown (CL)	10.0	A-7-6
								38		19						
15								17		18						
20								13		17					21.5	

End of Boring LF-3 @ 21.5'

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Shelby; Bulk Sample; Grab Sample; Ring Sample; Large Split Spoon; Special Samplers; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ___ ft Upon Completion of Drilling ___ ft
Time After Drilling ___
Depth To Water (feet) ___
Remarks:

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

LOG OF BORING

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 224+70, 95' Rt of CL		Borehole Number: LF-4	Sheet 1 of 1
Drilling Equipment: CME 75	Hammer Type: Auto	Driller: NTL Engineering	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/3/2007	Date Finished: 8/3/2007
Elevation and Datum: Ground: 3491.00	Casing:	Notes:	

DEPTH (feet)	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
0				**TOPSOIL, Organic Matter**	0.5	
	Split Spoon	18	7	**FILL, CLAY with Gravel**, very stiff to soft, moist, subround gravels, trace organics, some sand, wood debris, glass, ceramics, nails, copper wire, brown		
	Split Spoon	19				
5	Split Spoon	4	18			
10				seepage zone encountered @ 9.6'	10.6	
	Split Spoon	17	22	**Glacial TILL, Lean Clay with Sand and Gravel**, very stiff, moist, trace carbons, trace oxidation, some salts, subround gravels, brown (CL)		A-7-6
15	Split Spoon	23	18			
20	Split Spoon	23	19		21.5	

End of Boring LF-4 @ 21.5'

Columns DRILL (OPERATION, PRESSURE (psi), RATE (fph)), CORE PERCENT RECOVERY, ROCK QUALITY DESIGNATION (RQD), RECOVERY (%), DRY DENSITY (pcf), LIQUID LIMIT LL, PLASTIC LIMIT PL, GRAPHIC LOG: no values recorded.

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Shelby; Bulk Sample; Grab Sample; Ring Sample; Large Split Spoon; Special Samplers; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ___ ft   Upon Completion of Drilling ___ ft
Time After Drilling
Depth To Water (feet)
Remarks:

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

LOG OF BORING

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 226+75, 65' Rt of CL	Borehole Number: LF-5	Sheet 1 of 1	
Drilling Equipment: CME 75	Hammer: Type: Auto	Driller: NTL Engineering	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/3/2007	Date Finished: 8/3/2007
Elevation and Datum: Ground: 3491.50 Casing:	Notes:		

DEPTH (feet)	DRILL OPERATION	PRESSURE (psi)	RATE (fph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
														TOPSOIL, Organic Matter	0.5	
								17		8				**FILL, CLAY with Gravel**, very stiff, moist, subround gravels, trace organics, some sand, wood debris, glass, ceramics, brown		
								21								
5														seepage zone encountered @ 4.6'	5.0	
								PUSH	110	18				**Glacial TILL, Lean Clay with Sand and Gravel**, stiff to very stiff, moist, trace carbons, trace oxidation, some salts, subround gravels, brown (CL)		A-7-6
								17		24						
10								10		18						
15								23		18						
20								39		19					21.5	

End of Boring LF-5 @ 21.5'

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Ring Sample; Shelby; Large Split Spoon; Bulk Sample; Special Samplers; Grab Sample; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ___ ft Upon Completion of Drilling ___ ft
Time After Drilling
Depth To Water (feet)
Remarks:

LOG OF BORING

NTL Engineering & Geoscience, Inc.
1392 13th Ave SW
Great Falls, MT 59404
Phone: 406.453.5400
Fax: 406.761.6655

Project Name: Conrad I-15 North Interchange		Project Number: 06-340	
Borehole Location: Ramp C-3, Sta. 230+10, 60' Rt of CL	Borehole Number: B-9	Sheet 1 of 1	
Drilling Equipment: CME 75	Hammer: Type: Auto	Driller: Big Sky Drilling	Logger: M. Hoffmann
Drilling Fluid:	Borehole Diameter (in): 8	Date Started: 8/23/2006	Date Finished: 8/23/2006
Elevation and Datum: Ground: 3488.00	Casing:	Notes:	

DEPTH (feet)	OPERATION	PRESSURE (psi)	RATE (fph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (feet)	AASHTO CLASSIFICATION
0	Auger					Split Spoon	100	12		10				**TOPSOIL, Organic Matter**	1.4	()
	Auger													**Lean CLAY with Sand**, stiff to very stiff, slightly moist, trace organics, trace oxidation, some gravels, trace salts, brown (CL)	5.0	
5	Auger					Split Spoon	100	27		12				**Glacial TILL, Lean Clay with Sand and Gravel**, very stiff, moist, salts, subround gravels, brown (CL)		()
10	Auger					Split Spoon	100	24		12				larger calcium deposits @ 11'		A-7-6
15	Auger					Split Spoon	100	27		15						()
20	Auger					Split Spoon	100	19		15					21.5	()

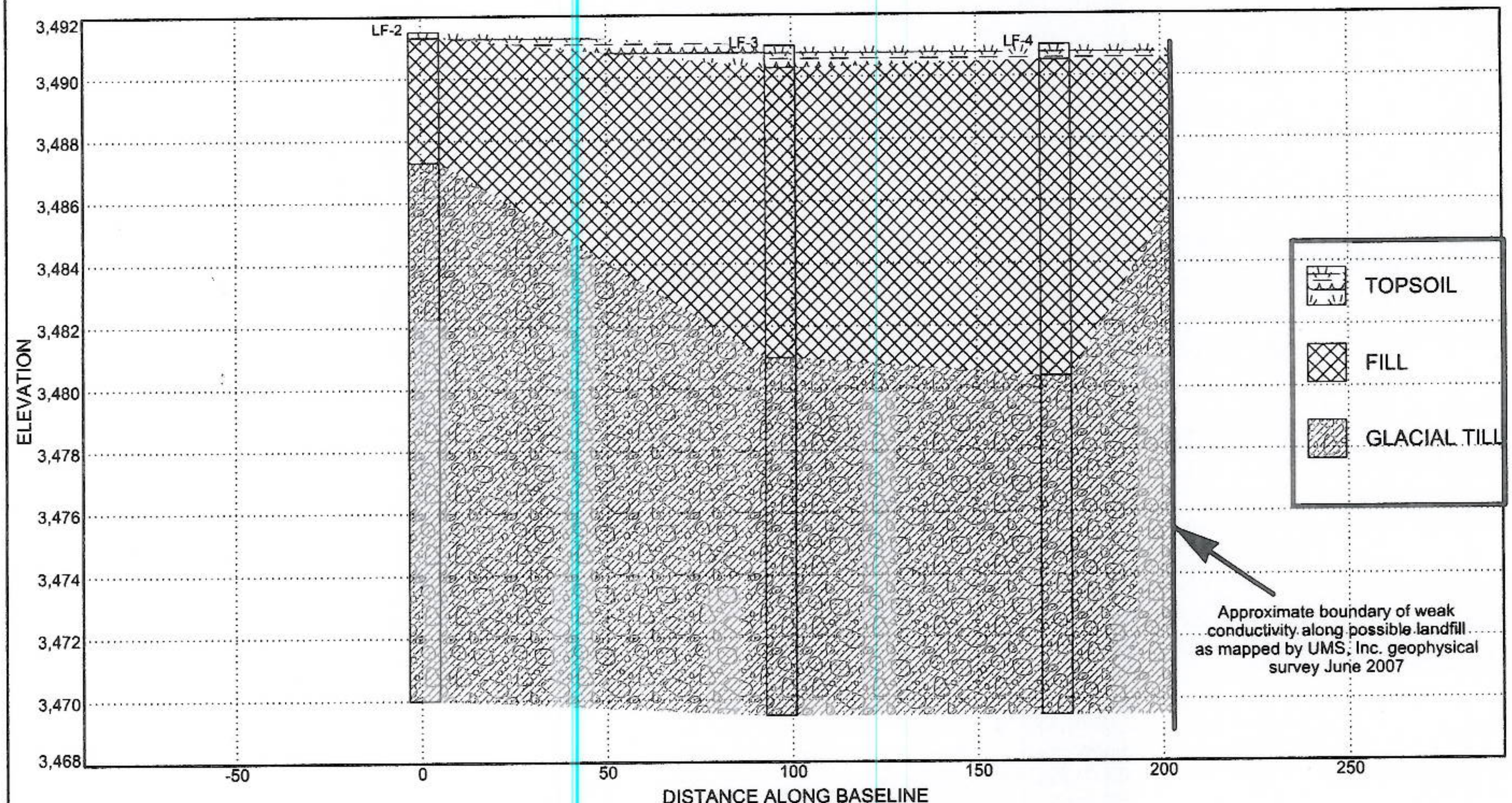
End of Boring B-9 @ 21.5'

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon (SPT); Shelby; Bulk Sample; Grab Sample; Ring Sample; Large Split Spoon; Special Samplers; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ____ ft Upon Completion of Drilling ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____
Remarks:



Borehole	North	East	ELEV	DEPTH
LF-2	1443104	1374949	3491.5	21.5
LF-3	1443137	1375047	3491.0	21.5
LF-4	1443098	1375119	3491.0	21.5

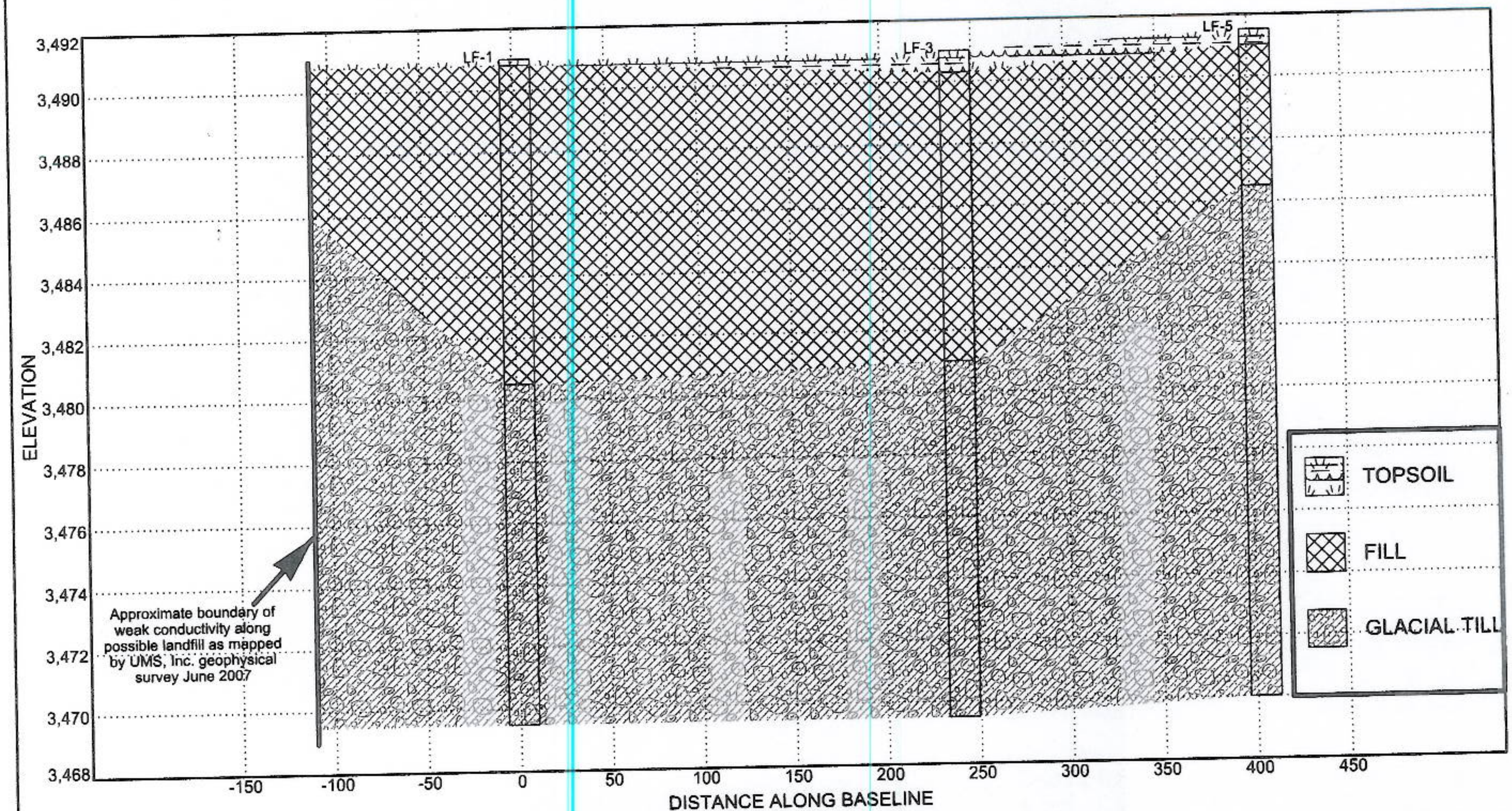
ENGINEERING GEOSCIENCE

GENERALIZED SUBSURFACE CROSS-SECTION

Conrad I-15 North Interchange

Conrad, Montana

PROJECT NO.	DATE	PLATE NO.
06-340	12-05-07	A-A



Borehole	North	East	ELEV	DEPTH
LF-1	1442921	1374943	3491.0	21.5
LF-3	1443137	1375047	3491.0	21.5
LF-5	1443281	1375125	3491.5	21.5

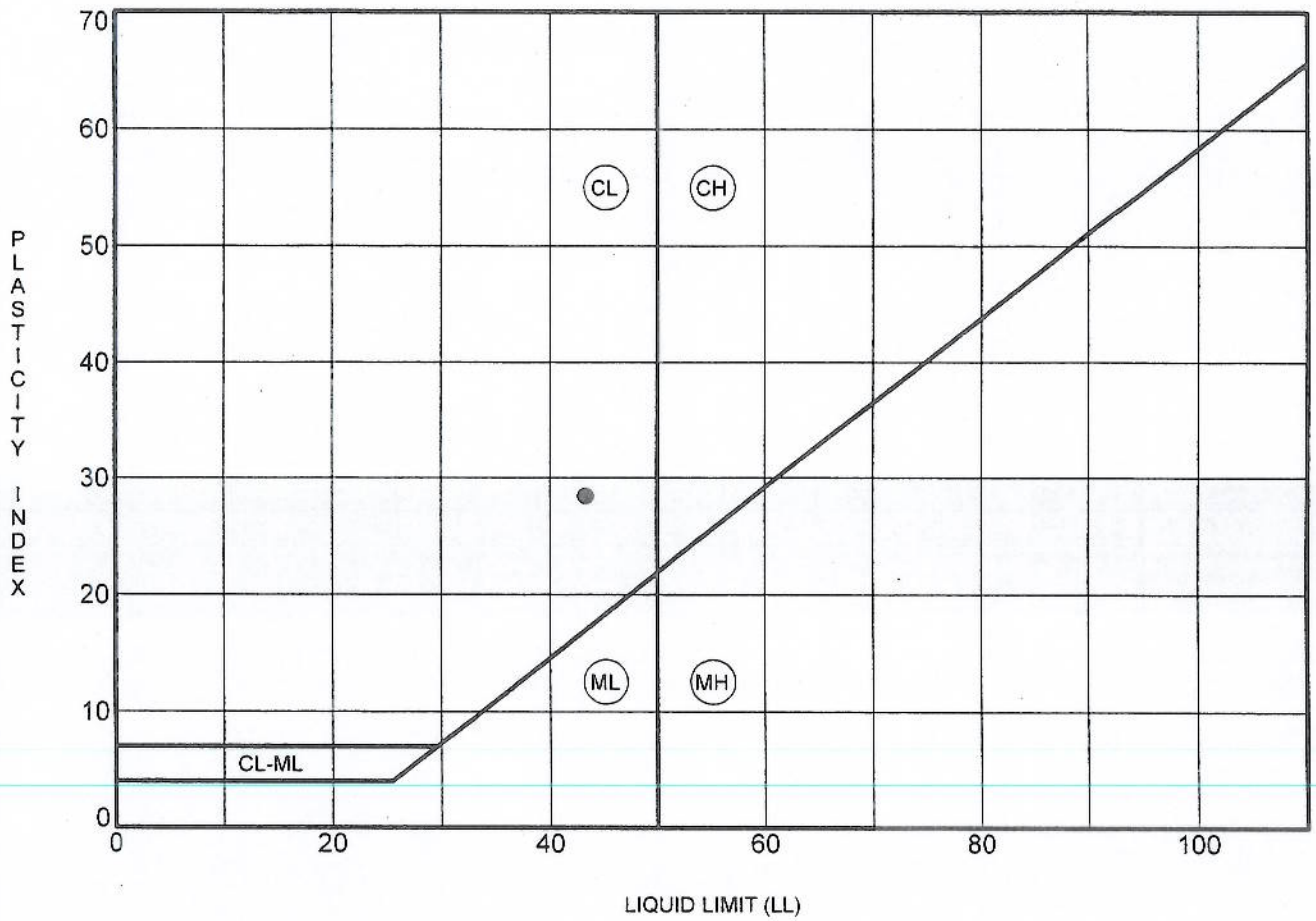
ENGINEERING NTL GEOSCIENCE

GENERALIZED SUBSURFACE CROSS-SECTION

Conrad I-15 North Interchange

Conrad, Montana

PROJECT NO.	DATE	PLATE NO.
06-340	12-05-07	B-B



	Specimen Identification		LL	PL	PI	Fines	Classification
●	EMB-1	2.5	43	15	28	75.8	FILL, Lean Clay With Sand (A-7-6)

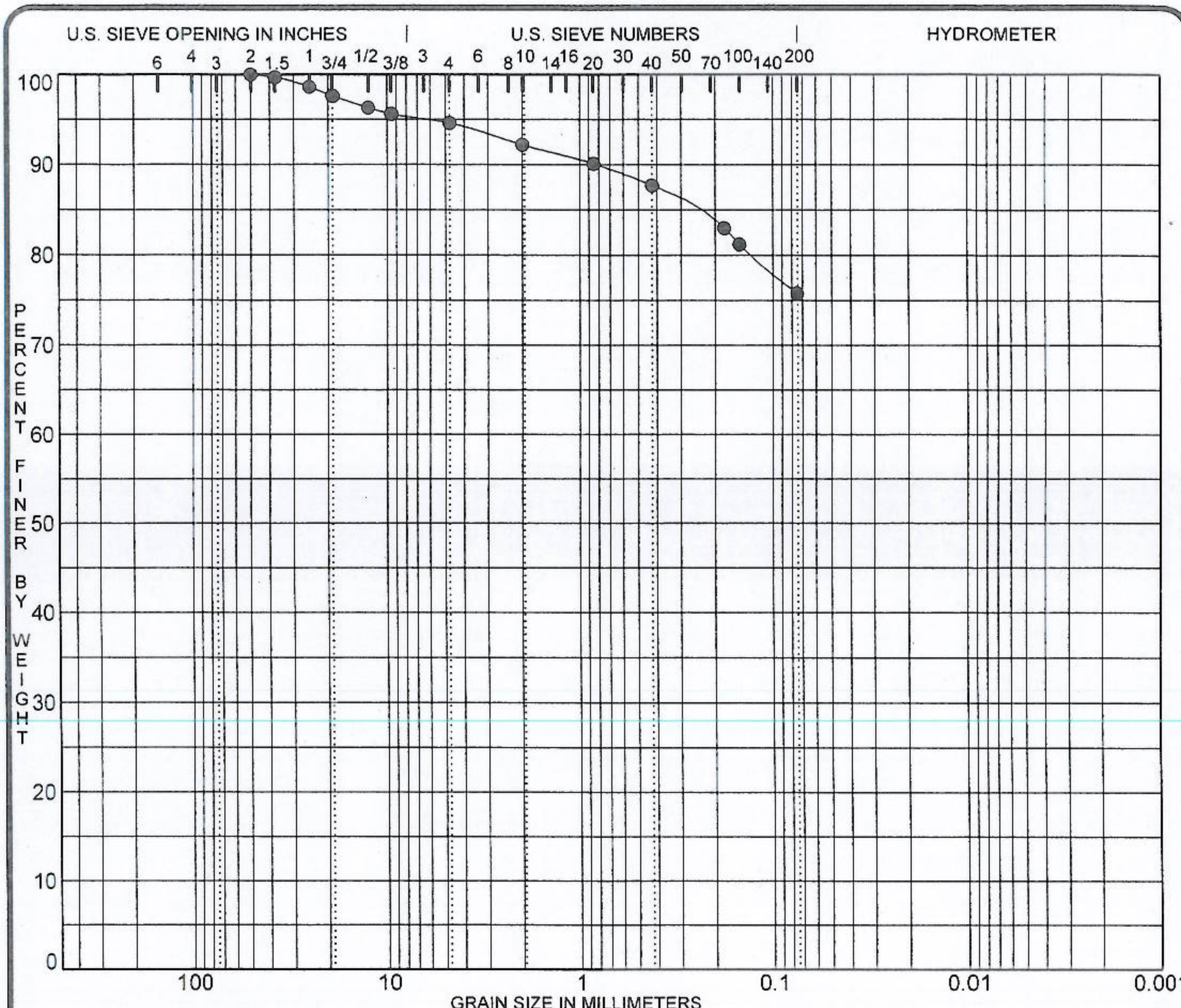
PROJECT **Conrad I-15 North Interchange**
Conrad, Montana

JOB NO. **06-340**
DATE **12/3/07**

ATTERBERG LIMITS

NTL Engineering & Geoscience, Inc.
Great Falls, MT 59404

Plate No. 1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
● EMB-1	2.5	**FILL, Lean Clay With Sand (A-7-6)**		43	15	28		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● EMB-1	2.5	50.00				5.4	18.8	75.8	

PROJECT **Conrad I-15 North Interchange**
Conrad, Montana

JOB NO. **06-340**
DATE **12/3/07**

GRADATION CURVES

NTL Engineering & Geoscience, Inc.
Great Falls, MT 59404

Plate No. 2

Point ID	Depth	Boring Location	ASTM Soil Class	AASHTO Soil Class	LL	PI	10 Mesh	40 Mesh	200 Mesh	Inplace Density (dry)	Maximum Dry Density	Percent Natural Moisture	Percent Optimum Moisture	Depth to Water Table	CBR
EMB-1	0.0	Ramp C-3, Sta. 227+20 390' Rt of CL	FILL									1.1			
EMB-1	2.5	Ramp C-3, Sta. 227+20 390' Rt of CL	FILL	A-7-6 (20)*	43.3	28.4	92.2	87.7	75.8						
EMB-1	5.0	Ramp C-3, Sta. 227+20 390' Rt of CL	FILL									16.4			
EMB-1	10.0	Ramp C-3, Sta. 227+20 390' Rt of CL	FILL									18.5			
EMB-1	15.0	Ramp C-3, Sta. 227+20 390' Rt of CL	FILL									17.6			
EMB-1	20.0	Ramp C-3, Sta. 227+20 390' Rt of CL	CL	A-7-6								17.3			
LF-1	0.4	Ramp C-3, Sta. 223+00 50' Lt of CL	FILL									6.0			
LF-1	1.7	Ramp C-3, Sta. 223+00 50' Lt of CL	FILL									12.1			
LF-1	5.0	Ramp C-3, Sta. 223+00 50' Lt of CL	FILL									20.9			
LF-1	5.2	Ramp C-3, Sta. 223+00 50' Lt of CL	FILL									21.2			
LF-1	10.0	Ramp C-3, Sta. 223+00 50' Lt of CL	FILL									17.2			
LF-1	15.0	Ramp C-3, Sta. 223+00 50' Lt of CL	CL	A-7-6								17.0			
LF-1	20.0	Ramp C-3, Sta. 223+00 50' Lt of CL	CL	A-7-6								17.7			
LF-2	0.2	Ramp C-3, Sta. 224+65 70' Lt of CL	FILL									8.2			
LF-2	1.7	Ramp C-3, Sta. 224+65 70' Lt of CL	FILL									12.6			
LF-2	5.0	Ramp C-3, Sta. 224+65 70' Lt of CL	CL	A-7-6								20.4			
LF-2	10.0	Ramp C-3, Sta. 224+65 70' Lt of CL	CL	A-7-6								18.0			
LF-2	15.0	Ramp C-3, Sta. 224+65 70' Lt of CL	CL	A-7-6								16.5			
LF-2	20.0	Ramp C-3, Sta. 224+65 70' Lt of CL	CL	A-7-6								17.5			
LF-3	0.7	Ramp C-3, Sta. 225+15 18' Rt of CL	FILL									13.6			
LF-3	5.0	Ramp C-3, Sta. 225+15 18' Rt of CL	FILL									25.7			
LF-3	10.0	Ramp C-3, Sta. 225+15 18' Rt of CL	CL	A-7-6						114		16.4			
LF-3	12.0	Ramp C-3, Sta. 225+15 18' Rt of CL	CL	A-7-6								18.6			
LF-3	15.0	Ramp C-3, Sta. 225+15 18' Rt of CL	CL	A-7-6								17.7			
LF-3	20.0	Ramp C-3, Sta. 225+15 18' Rt of CL	CL	A-7-6								17.3			

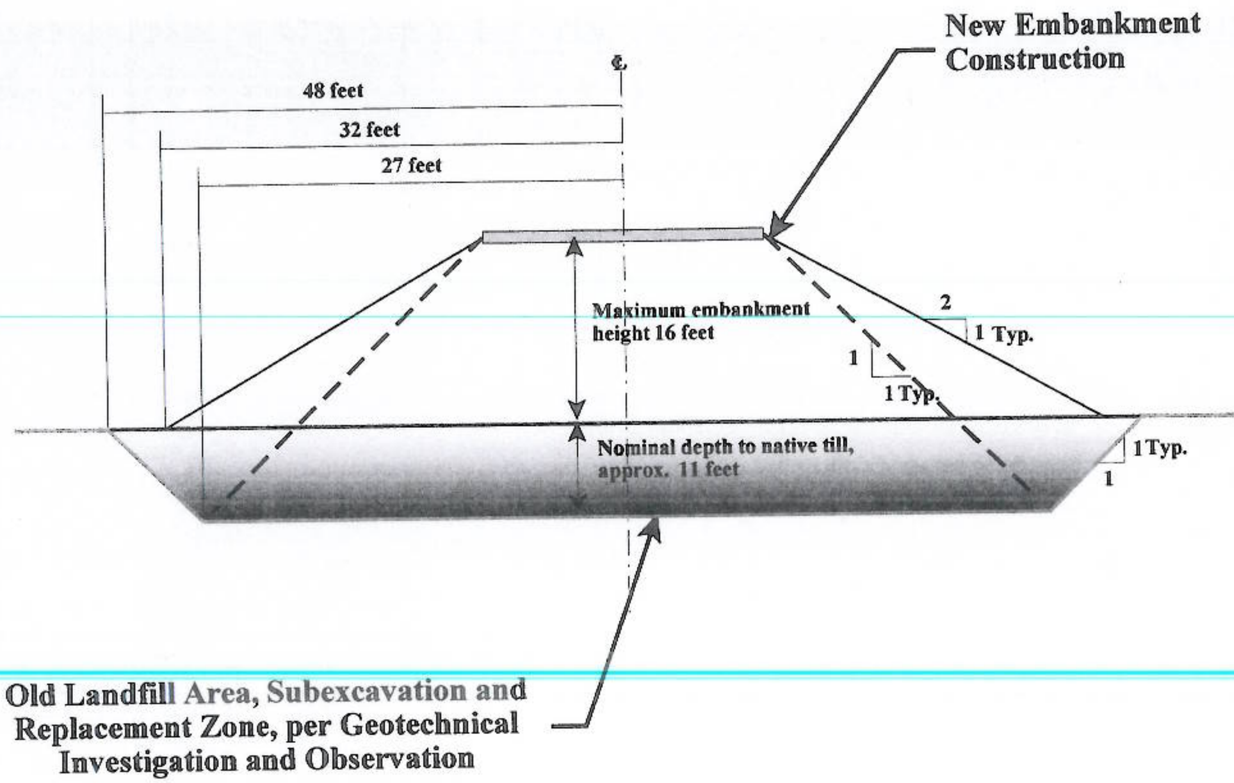
Conrad I-15 North Interchange

06-340

Modified Lab Form 111

Point ID	Depth	Boring Location	ASTM Soil Class	AASHTO Soil Class	LL	PI	10 Mesh	40 Mesh	200 Mesh	Inplace Density (dry)	Maximum Dry Density	Percent Natural Moisture	Percent Optimum Moisture	Depth to Water Table	CBR
LF-4	0.5	Ramp C-3, Sta. 224+70 95' Rt of CL	FILL									7.2			
LF-4	5.0	Ramp C-3, Sta. 224+70 95' Rt of CL	FILL									18.5			
LF-4	10.0	Ramp C-3, Sta. 224+70 95' Rt of CL	FILL									22.0			
LF-4	10.6	Ramp C-3, Sta. 224+70 95' Rt of CL	CL	A-7-6								17.6			
LF-4	15.0	Ramp C-3, Sta. 224+70 95' Rt of CL	CL	A-7-6								17.8			
LF-4	20.0	Ramp C-3, Sta. 224+70 95' Rt of CL	CL	A-7-6								19.1			
LF-5	0.5	Ramp C-3, Sta. 226+75 65' Rt of CL	FILL									7.6			
LF-5	5.0	Ramp C-3, Sta. 226+75 65' Rt of CL	CL	A-7-6						110		17.6			
LF-5	7.0	Ramp C-3, Sta. 226+75 65' Rt of CL	CL	A-7-6								24.1			
LF-5	10.0	Ramp C-3, Sta. 226+75 65' Rt of CL	CL	A-7-6								18.1			
LF-5	15.0	Ramp C-3, Sta. 226+75 65' Rt of CL	CL	A-7-6								18.0			
LF-5	20.0	Ramp C-3, Sta. 226+75 65' Rt of CL	CL	A-7-6								18.6			

* Atterberg Limits and Gradation testing performed on Fill sample at EMB-1 for use in Shrink/Swell estimation of using existing embankment for new construction.



No Scale Intended

Project: Conrad I-15 North Interchange
Pondera County, Montana

Job Number: 06-340
Date: December 17, 2007

Conceptual Construction Excavation Limits

NTL Engineering and Geoscience
Great Falls, MT

Detail 1

Conrad I-15 North Interchange 2H:1V Embankment Slope, Fill Foundation

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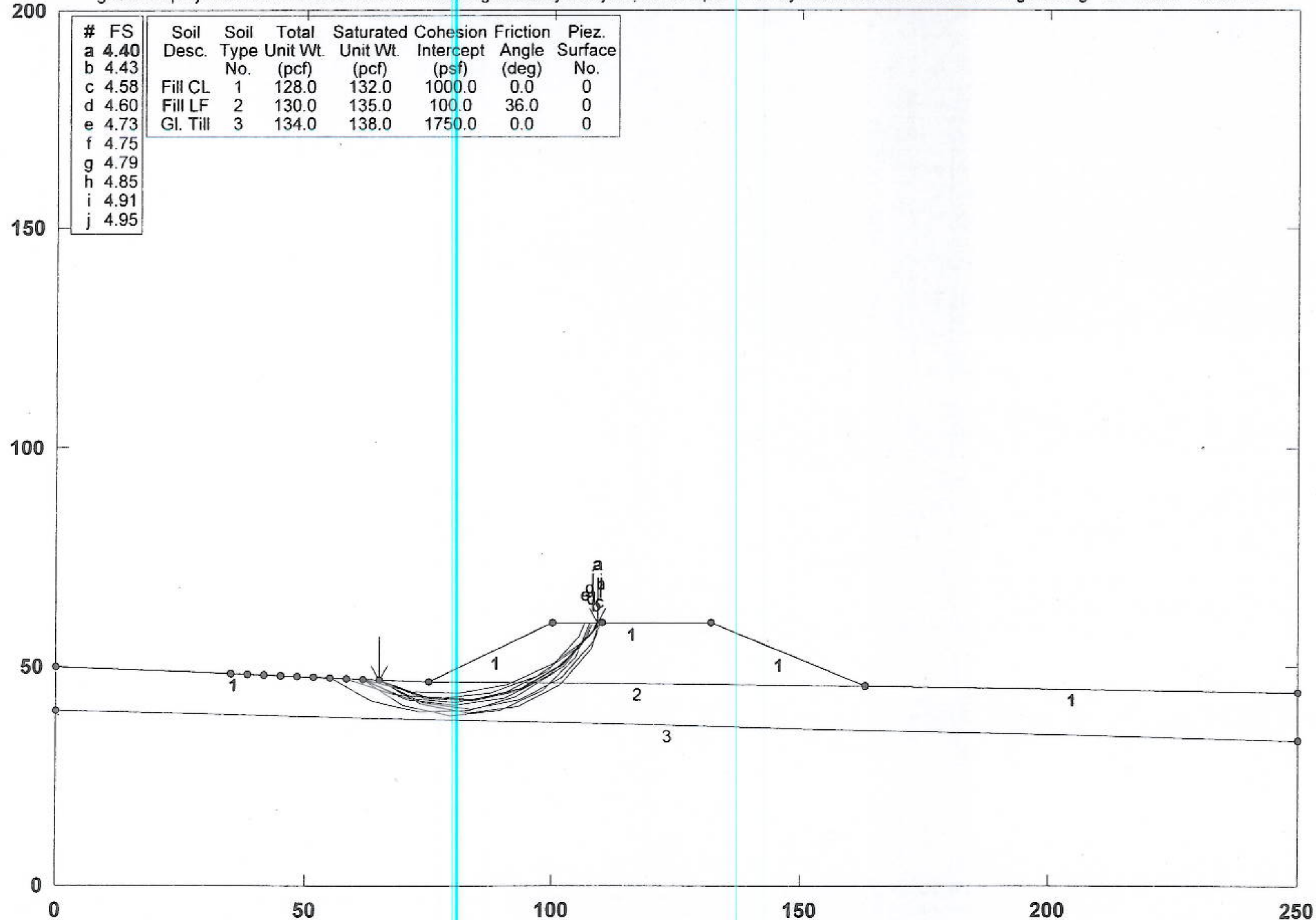

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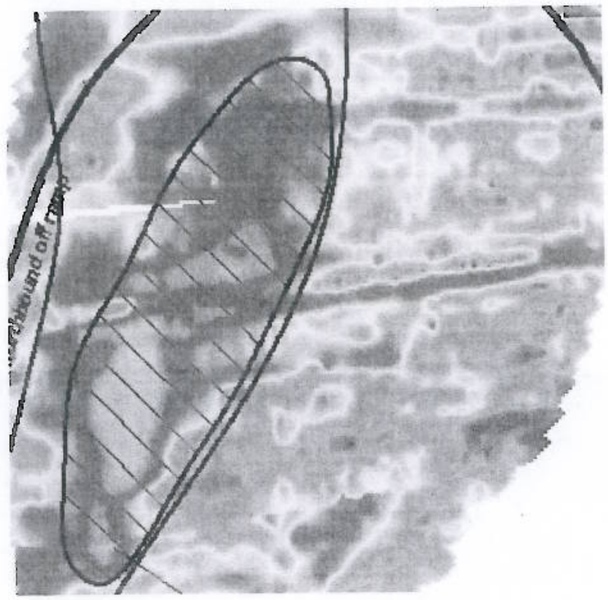
Safety Factors Are Calculated By The Modified Janbu Method for the case of phi=0

STED



December 15, 2007

VARIABLE FREQUENCY EM GEOPHYSICAL SURVEY SERVICES
Landfill Boundary Mapping

Conrad I-15 North Interchange
NT15-7(32)339, CN 5944

Submitted to:

Morrison Maierle, Inc.
1 Engineering Place
P.O. Box 6147
Helena, MT 59604

MORRISON MAIERLE, INC.

Submitted by:

Utility Mapping Services, Inc.
1 Valley View Drive, Suite 104
Montana City, MT 59634
Ph: 406.933.5300

TABLE OF CONTENTS

GEOPHYSICAL SURVEY – EM Investigation to Define Landfill Boundary
Project: Conrad I-15 North Interchange
Project Number: NT15-7(32)339, CN 5944

Section 1 – General Statement of Scope of Work

Utility Mapping Services (UMS) performed geophysical survey services as a sub-consultant to support the subject design project in which Morrison Maierle, Inc. (a.k.a. "Client") is serving as a prime design engineering consultant for the Montana Department of Transportation (MDT). The work objective was to delineate the perimeter of a landfill formerly used by the City of Conrad but abandoned and buried during the construction Interstate 15 during the 1960s. A geophysical electromagnetic (EM) conductivity survey using a Geophex, Ltd. GEM-2 sensor was used to identify potential zones of buried landfill debris and facilitate placement of geotechnical borings to characterize subgrade content and depth of disturbance.

The survey was performed within project limits identified by the Client as described in this submittal. UMS performed the following activities:

- developed geophysical survey plan
- mobilized equipment and personnel to project location
- conducted geophysical survey of project area concurrent with real-time GPS survey
- reduced data, prepared geophysical anomaly maps, conducted interpretation
- prepared this report summarizing findings, discrepancies, and recommendations
- performed quality assurance review of plans
- provided registered professional engineer of record seal for geophysical investigation
- reviewed results with the design team and recommend strategic boring locations

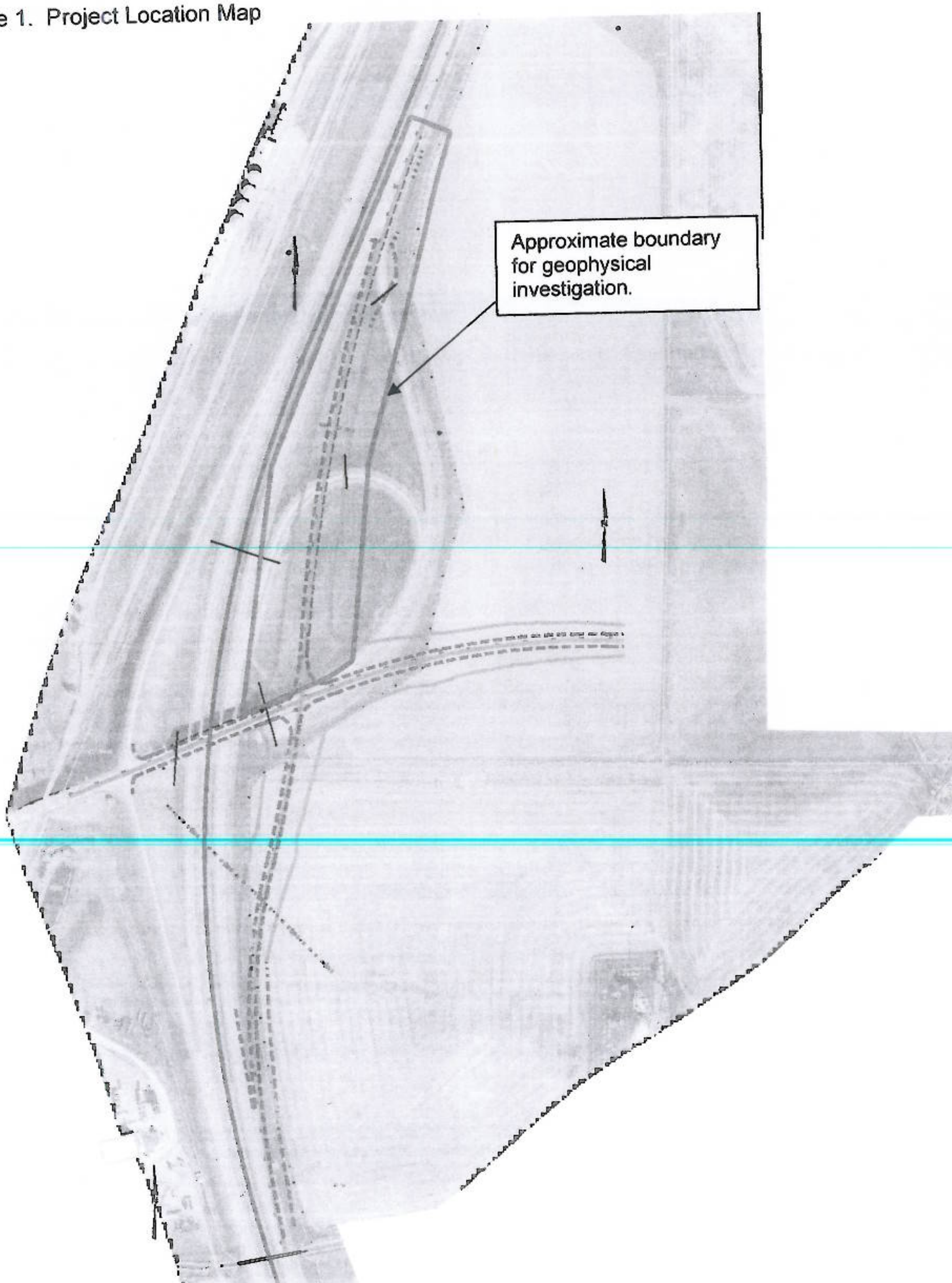
UMS performed geophysical services in accordance with generally accepted engineering principles and practices and in accordance with applicable standards at the time of this investigation.

Section 2 - Project Specific Scope of Work

The project is located at and includes the I-15 interchange at Conrad. Figure 1 illustrates the project limits for the EM conductivity investigation.

The geophysical investigation area consists of swaths centered along the proposed ramp and road improvement construction footprints. The investigation area is in the intersection northeastern quadrant and extends roughly 2,200 feet along the eastern right of way for I-15. The investigative swath width is roughly 400 feet wide and extends approximately 100 feet beyond the current construction footprint for the ramps and roadway.

Figure 1. Project Location Map



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UMS conducted a geophysical survey of the former Conrad municipal landfill using the variable frequency EM method as described below.

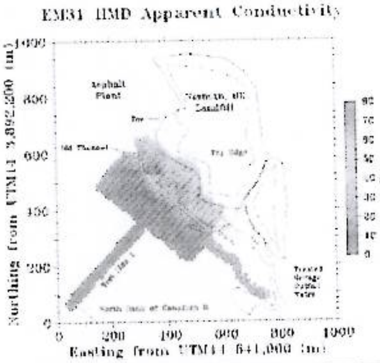


Figure 2. Example of EM survey to delineate a landfill boundary.

Phase I – EM Survey

The EM field survey of the Conrad / I-15 interchange is to delineate the lateral extent of the historic landfill and utilized a variable frequency EM sensor (Geophex Ltd. GEM-2) for conducting a survey of subgrade apparent conductivity variance. The following web link provides information on the tool and method:
http://www.geophex.com/Product_page/GEM2/How%20it%20works/howitworks.htm

The EM survey is used to detect buried conductive debris commonly associated with municipal landfills and can also provide insight into subgrade deviations caused by ground water presence.

The survey area encompassed the existing and proposed interchange ramp facilities with dimensions of approximately 400 ft x 2200 ft, and the portion of the cross road extending toward the east encompasses approximately 400 ft x 1000 ft. To accommodate the irregular survey area, variable terrain and numerous obstructions, the survey was conducted using RTK GPS. The GPS system consisted of a base unit and a rover with an accuracy tolerance target of +/- 0.1 feet. Based on field results, a portion of the lines were extended as necessary to record native background ambient field conditions; this aided in differentiating anomalies caused by the landfill and other cultural influences. Traffic control was not necessary.

Deliverables consisted of this report and an EM apparent conductivity digital overlay in MicroStation format which can be referenced into MDT CADD Standard MicroStation design files to depict interpreted landfill boundaries and aid the selection of core drilling locations.

Section 3 – Survey Results

Field operations were conducted on June 29, 2007. Survey lines had a nominal spacing of 10 ft, with station spacing along survey lines at 1 ft. This line spacing and sampling frequency resulted in obtaining 92,028 lineal feet of EM data, comprised of approximately 92,028 records. Data was collected for both in-phase and quadrature components at frequencies 450 Hz, 1590 Hz, 5610 Hz, and 19950 Hz. Figures 3 and 4 present color contrast maps illustrating the quadrature component of the EM survey for frequencies 5690 Hz and 1590 Hz respectively. The images for the in-phase and quadrature components of other frequencies were consistent with those shown in Figures 3 and 4. Figure 5 presents an interpretation summary for in-phase and quadrature components recorded for frequencies 450 Hz, 1590 Hz, 5610 Hz, and 19950 Hz. Also illustrated are the survey lines for which data acquisition was performed to generate the anomaly maps. Figures 6 and 7 present superpositions of the anomaly map over the aerial topography.

The GEM-2 data presents a weak conductivity anomaly extending along a north-south alignment as labeled on the figures. The signal to noise ratio was weak, therefore slight deviations in instrument height due to adjustments made by the operator resulted in some lineal east-west striping on the color contrast map.

The anomaly map appears to indicate a conductive zone which may be due to buried debris associated with the former landfill. Results from the August 3rd, 2007 geotechnical drilling campaign indicate a good correlation between buried landfill debris found in boring samples and the interpreted boundary. Boring B-9 shown on Figure 7 was drilled 15 feet to the east of the interpreted landfill boundary and did not reveal any debris, while all the all of the borings drilled within the interpreted landfill boundary had debris within the cuttings. It is noteworthy that the geophysical interpretation provided in Figures 3 through 7 was made prior to the August 3rd drilling campaign and was independently derived. All of the geotechnical borings agreed with the geophysical interpretation.

The northern tip of this zone was not interpreted due to interference from an existing fence and the ramp pavement section; however, the conductive trend does seem to infer a continuation toward the north which could be associated with buried debris. Therefore, it would be reasonable to assume that the historic landfill extends northward beyond the study zone as indicated on the color contrast anomaly map.

Section 4 – Conclusions

Buried debris revealed in boring data collected August 3rd, 2007 correlate very well with the geophysical EM data collected in late June 2007. Based on the EM survey, a weakly conductive zone assumed to be associated with the historic landfill appears to extend north-northeastward as shown on the color contrast maps. The EM data at the northern tip of the survey indicates the debris was removed beneath the existing NB on-ramp during the original construction of I-15. However, the conductive anomaly appears to continue northward beyond the study zone.

Figure 3. GEM-2 Response of EM quadrature component for 5690 hertz

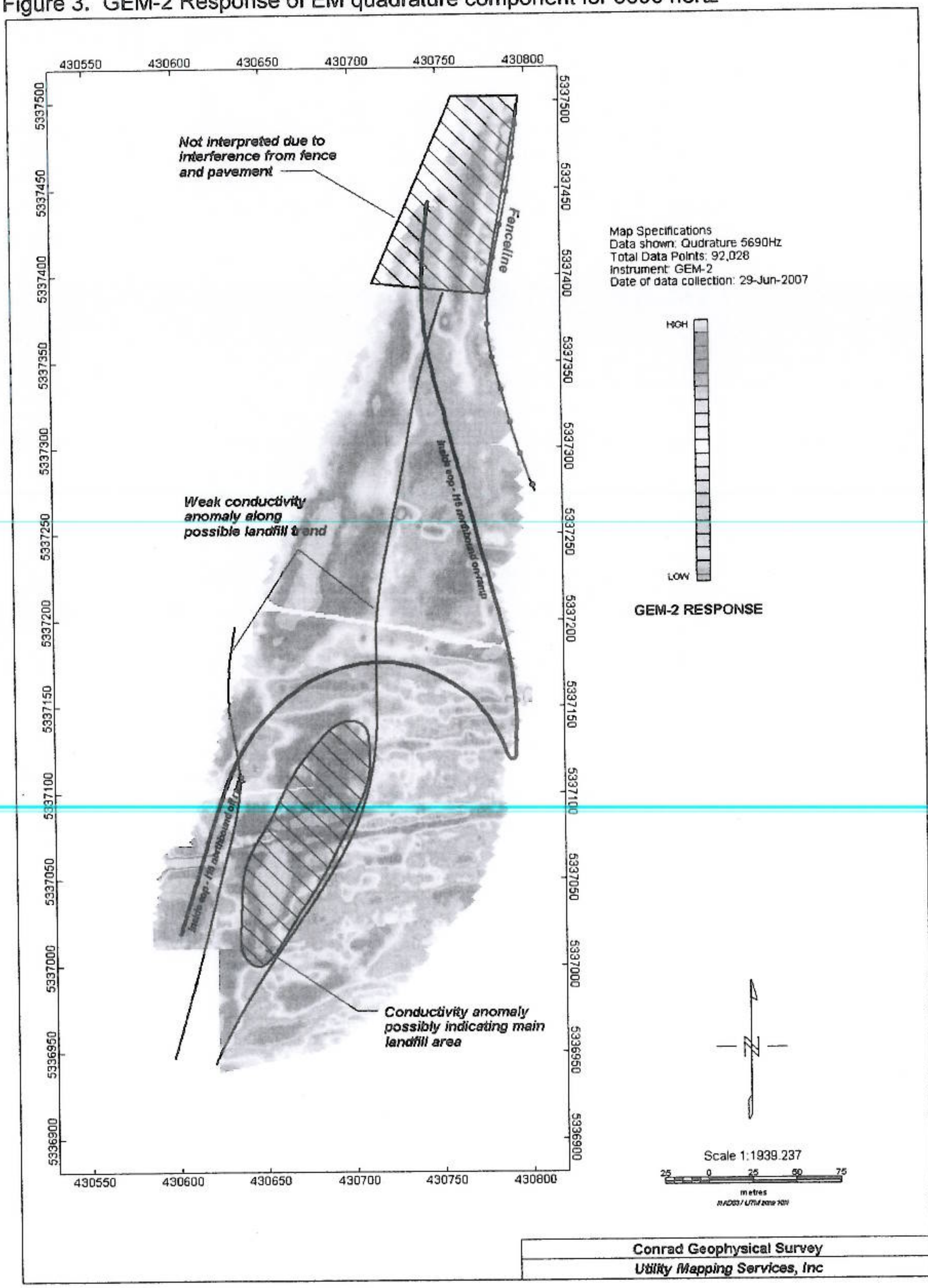


Figure 4. GEM-2 Response of EM quadrature component for 1590 hertz

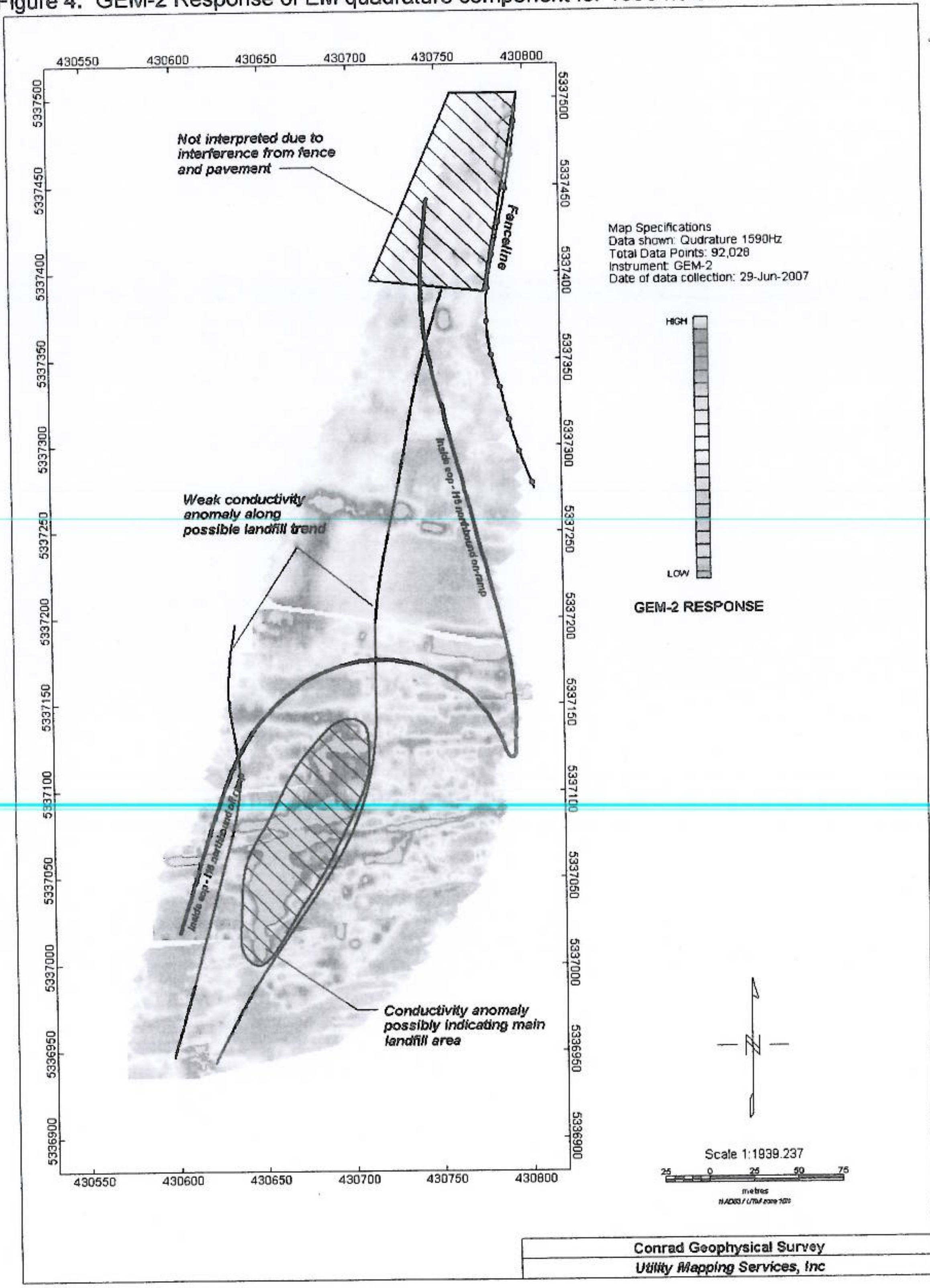


Figure 5. Summary interpretation of GEM-2 data

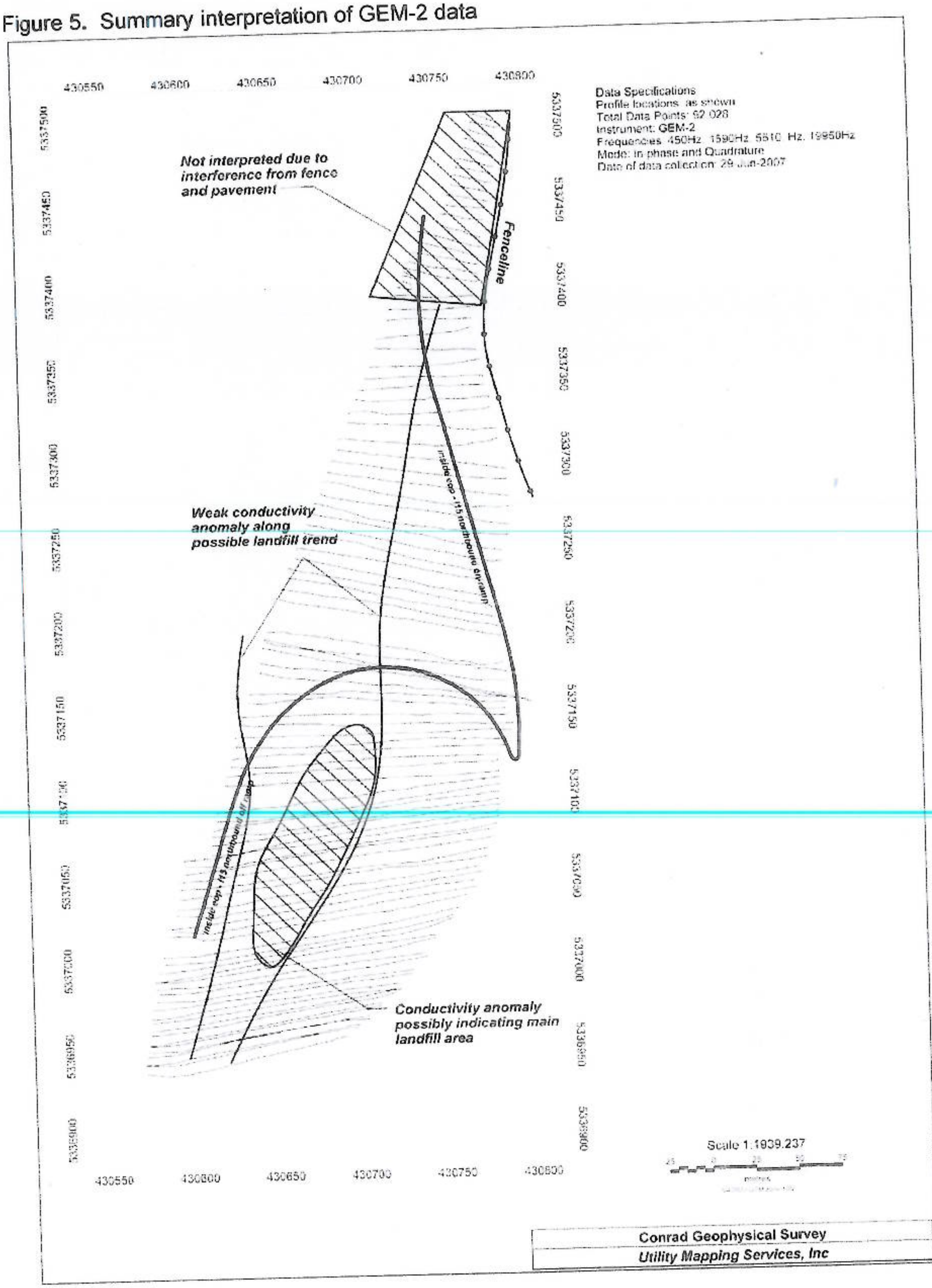
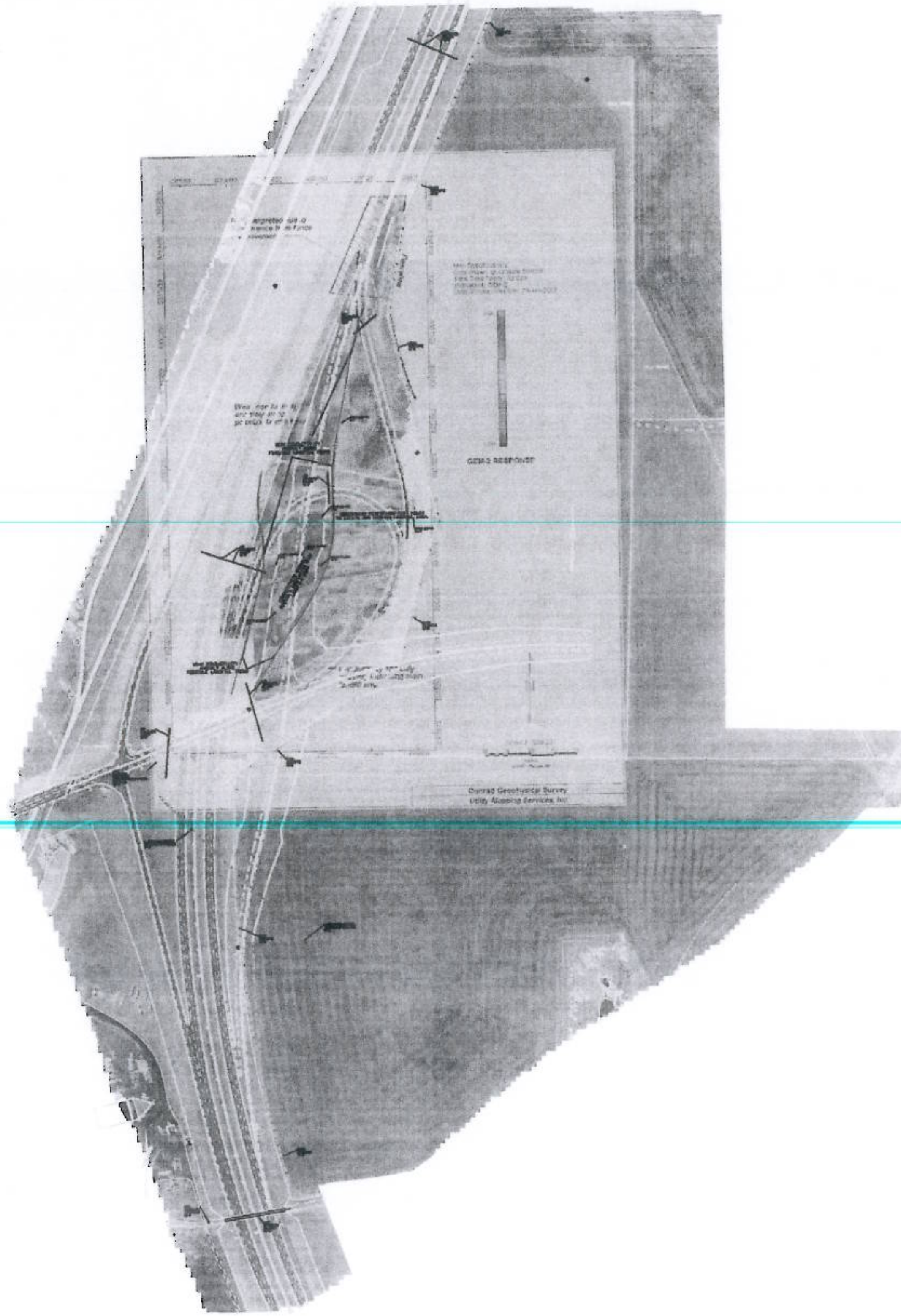
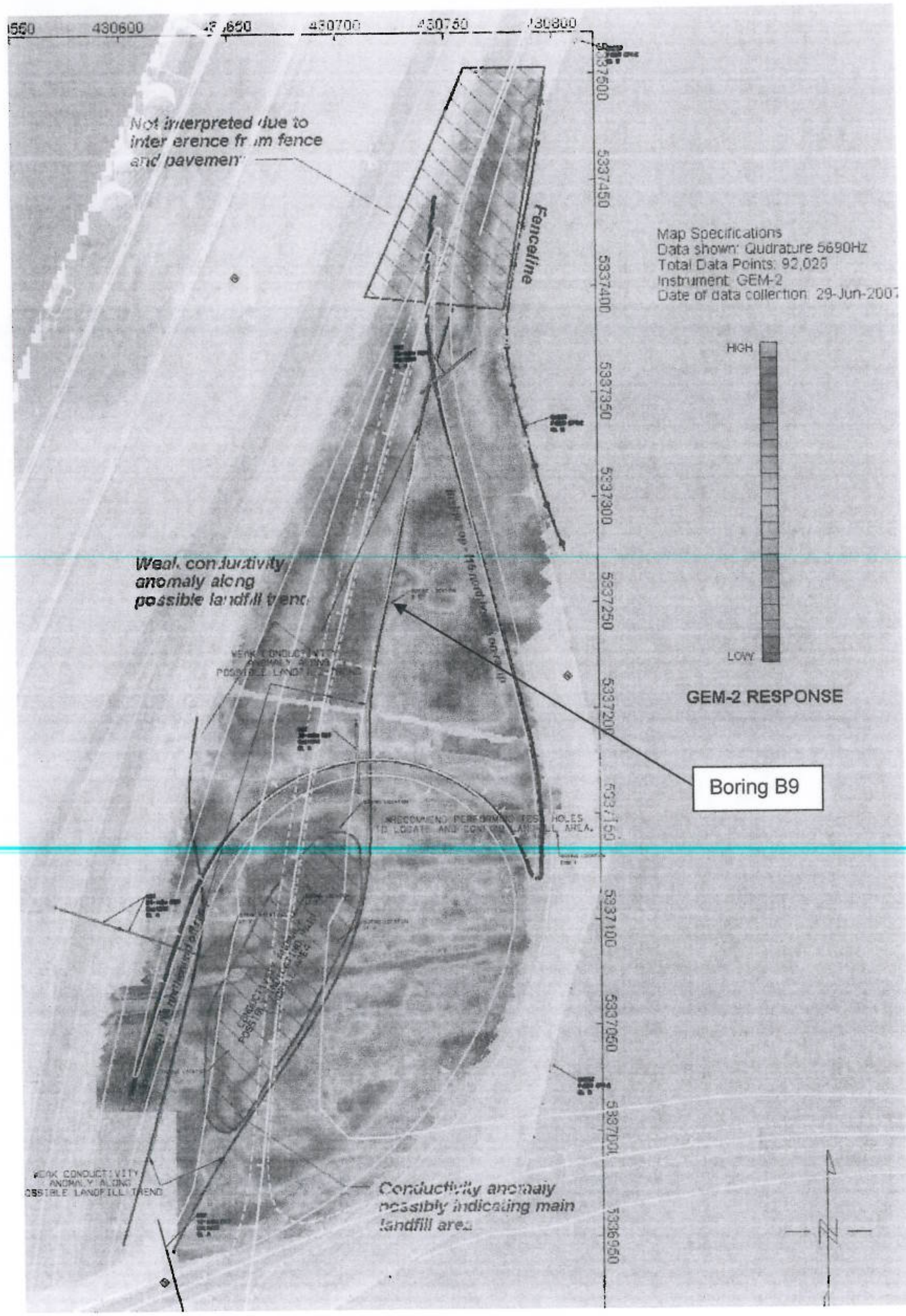


Figure 6. Topographic and boring data with 5690 Hz quadrature anomaly map overlay




430600
430700
Not interpreted due to
and pavement
Fenceline
Map Specifications
Data shown: Qudrature 5690Hz
Total Data Points: 92,025
Instrument: GEM-2
HIGH
LOW
GEM-2 RESPONSE
Boring B9
Conductivity anomaly
possibly indicating main
landfill area
5337600
5337450
5337400
5337350
5337300
5337250
5337100
5337050
5336950